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THE ADVANTAGE OF PLANTING HEAVY COTTON SEED.

BY

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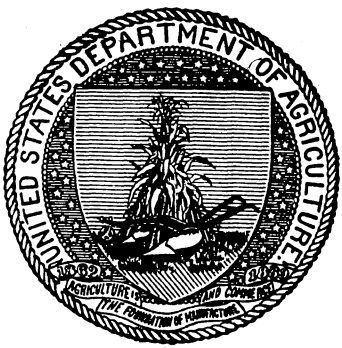

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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., March 5, 1907.

SIR: I have the honor to transmit herewith a paper entitled "The Advantage of Planting Heavy Cotton Seed," prepared by Dr. H. J. Webber, Physiologist in Charge of the Plant Breeding Investigations of this Bureau, and Mr. E. B. Boykin, a special agent of the same office. This paper embodies the results of experiments in the separation of cotton seed, and shows the advantage to growers of making such a separation of their seed for planting. The methods presented and the apparatus described are new and are of great importance to the cotton industry. The paper should, therefore, be distributed broadcast among cotton planters, and I recommend its publication as a Farmers' Bulletin.

Very respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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THE ADVANTAGE OF PLANTING HEAVY COTTON SEED.

HEAVY VERSUS LIGHT SEED.

The importance of using heavy seed is in many crops well established. Seed grains, for instance, are quite generally subjected to some degree of separation. In tobacco the great importance of using large and heavy seed has been demonstrated by Mr. A. D. Shamel in the course of experiments conducted by the Bureau of Plant Industry of the Department of Agriculture. In this crop the tests of light and heavy seed have proved that the best developed and most vigorous plants are always produced from the heavy seeds, while the light seeds produce small, irregular, and undesirable plants.[a]

To insure a vigorous development of plants it is important to have a large quantity of nutriment stored in the seeds. Heavy seeds are the only ones which meet this condition, and, as a rule, the heavier they are in proportion to their volume the higher is the percentage of germination, the more rapid is the growth of the resulting plants, the more resistant are they to disease and adverse conditions, and the greater is their productiveness. Light seeds, on the other hand, germinate poorly and produce plants of low constitutional vigor, which are readily attacked by diseases and which possess a comparatively low degree of productiveness.

It is therefore important to subject seed for planting to some process of separation by which the light and inferior seeds are eliminated. Such a separation can readily be effected with seeds having smooth seed coats, as, for instance, corn, wheat, peas, and tobacco. A number of methods have been devised which are applicable to the separation of such seeds, and in the case of a number of important crops extensive experiments have been conducted with separated seeds. The results strongly indicate the superiority of heavy seeds and the advisability of separation.

Comparatively little experimental work has been done in the separation of cotton seed, but in view of the beneficial results obtained in the case of other crops there is no apparent reason why similar results should not be obtained with cotton by a separation which eliminates the light and inferior seeds. The seeds of Upland varieties of cotton are covered with a dense fuzz (fig. 1, A), which holds them together and prevents their separation by any of the methods which are applicable to the separation of smooth seeds, and heretofore no

[a] Shamel, A. D. The Improvement of Tobacco by Breeding and Selection. Yearbook, Department of Agriculture, 1904, pp. 440–452.

practical method has been devised to meet these conditions. In view of this fact and the possibility of increasing the yield in this way, it was decided to make some effort to devise a method which would be adapted to the separation of cotton seeds. Fortunately, the experiments have been very successful, and it is now possible to recommend what appears to be a thoroughly practicable and successful method.

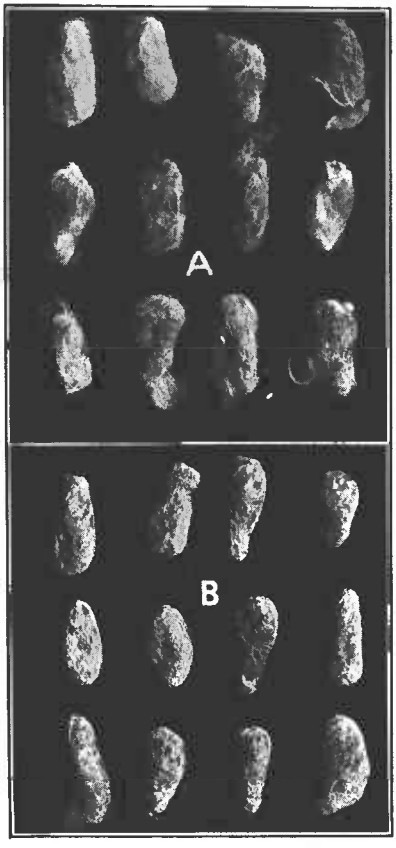

FIG. 1.—Seeds of fuzzy Upland cotton, before and after rolling: A, untreated; B, rolled by flour-paste method.

PREPARATION OF SEED FOR SEPARATION.

It was evident from the beginning that the fuzz which covers the seed in ordinary varieties of cotton would either have to be removed or treated in some way to paste it down and thus prevent the seeds from clinging together. To remove this fuzz would probably require the use of expensive machinery which the majority of growers could not purchase or to which they would not have access. However, it was found that by rolling the seeds in some finely pulverized material and water, the fuzz could be so thoroughly pasted down as to prevent the seeds from adhering together and thereby enable each one to be acted upon individually in the process of separation. This rolling process is no doubt familiar to many growers, as it has been frequently employed in preparing seed for planting in cases where planters are to be used which are not adapted to fuzzy seed. The old planters which first came into use required the rolling of the seed before planting, and some of the modern planters also require this treatment.

The necessary apparatus for rolling the seeds can be provided at a very small cost. The one used in connection with these experiments consists of a wooden hexagonal box with a wooden axle extending through its center, supported at each end, and having a crank attached at one end for turning (fig. 2). It has an opening on one side through which the seeds can be put in or taken out and which is closed during the rolling process by means of a hinged door. Probably a

more convenient way of making such an apparatus is to use a large barrel, similar to a petroleum barrel, through which a wooden axle can be inserted, and the other details arranged according to the above description.

There are a number of materials which can be used to roll the seed in, and almost any finely pulverized material will do; but among those which are most likely to be available on a farm are ashes, acid phosphate, and fine, dry soil. A small quantity of such material and water should be sprinkled through the seed as it is put into the barrel, and more should be added gradually as the rolling proceeds until there is sufficient to thoroughly paste down the fuzz. The quantity will vary somewhat according to the variety of seed, for it will take more for a given quantity of small seeds than of large ones, as they will have a greater surface area. However, with a little experience it is very easy to determine how much should be used to get the best results. It is important to guard against the use of excessive quantities, especially of water, as this will prevent a satisfactory separation. The rolling should be very thoroughly done and should continue until the seeds fall apart very readily. This rolling process is not entirely satisfactory, as it probably introduces a slight element of error in the separation, owing to the fact that in some cases it slightly changes the relative weights of the seeds.

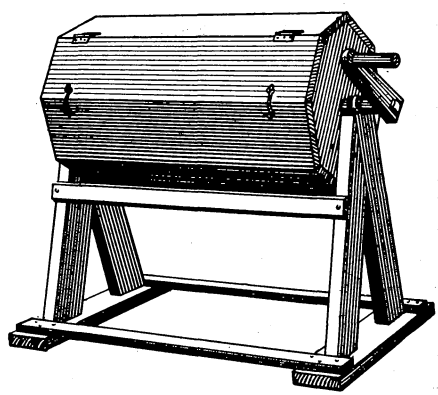

FIG. 2.—Apparatus used in rolling seed.

In the first separation experiments conducted by the writers the above methods of rolling and cementing down the fuzz were followed. It was later found that the same object could be accomplished much more easily and thoroughly by using flour paste, a material which, so far as the writers are informed, has never before been used. To treat seed by this method, take an ordinary drinking glass full of flour (from 4½ to 5 ounces) and mix it thoroughly with one pint of water, stirring it until the flour is thoroughly mixed with the water and not lumpy. Then add 1 quart more of water and boil until it thickens and becomes pasty. It will be observed that this is the same process used by housewives in making flour paste and flour gravy.

After cooling the paste, place 1 bushel of cotton seed in the rolling apparatus and pour the paste over it. Then close, and roll the seed from seven to ten minutes, after which it can be dumped out and

spread on the floor of the barn or in some other convenient place to dry. It has been found that seed treated in this way can be spread out in a layer from 3 to 4 inches deep and dried without difficulty. It was at first thought that the seeds would stick together in drying, but this has not proved to be the case. If more than one bushel of seed is to be rolled at one time, increase the quantity of paste used in proportion. By this method the seeds are coated with a thin pellicle of paste, which sticks the fuzz down firmly and allows the seeds to fall apart readily (fig. 1, B). The seeds after treatment remain in the same condition permanently until moistened or soaked in water, and the paste in no way interferes with their use in feeding or for other purposes, if desired later.

When the fuzz is stuck down by using ashes, fine soil, etc., as described previously, the seeds must be separated while still quite damp, as the hairs on drying straighten out and the dust rattles out, so that they begin to adhere again. This necessity of separating them while still moist increases the element of error in the separation, owing to the weight of both the water and the material adhering to the seed. Again, if the rolling is to have any effect in the planting, the seeds must be put in the planters and planted while still moist. This bunches the work of separation and planting so much as to make it difficult for the planter to carry it out successfully. By using the flour-paste method these difficulties are avoided. The rolling and separation of the seed can be done in the winter, when there are no rushing farm operations under way and when there is an abundance of labor. Separating the seed at this time will cost the planter scarcely anything, as it can be done at odd times when the helpers would otherwise be idle. The seeds treated by the paste method are dried before separation, so that the element of error is reduced, and the seeds after treatment remain in the same condition as long as they are kept dry. In the spring they will thus be in excellent condition to run through the planter easily. By this method, furthermore, the fuzz is so completely pasted down and the seeds roll apart so easily that it is believed they can be planted with perfect satisfaction in the ordinary double-row corn planters, which check the seed in hills. As there is a growing tendency to plant cotton in rows both ways, so that it may be cultivated more completely by machinery, it is believed that this simple discovery of attaching the fuzz by use of flour paste is of great importance to the industry as a whole. If planted with a corn planter and dropped at regular distances without reference to placing them in rows both ways, this method will even then be of great importance, as it facilitates dropping, insures uniformity in the number of seeds dropped, and does away with much of the labor necessary in thinning when cotton is planted in the ordinary way.

METHOD OF SEPARATING SEED.

In searching for a practical method of separating the heavy from the light seeds after they had been rolled as previously described, several available fanning mills and shaking machines of various types were tested, but in no case was a satisfactory separation obtained with existing machines. The experiments with air-blast fanning mills, where the current of air is directed for a short distance through a flue, gave indications of success. By experiments with such machines it was found that a successful separator must contain a flue of considerable length through which a strong blast of air can be directed and in which the seed may be exposed fully to the action of the air. In a long tube the seeds boil up and down under the action of the air current, giving an opportunity for the heavy ones to fall, while the light ones are carried on and finally blown out. A plan was devised for a special machine, but it was found that one of the ordinary types of air-blast fanning mills could be modified into about the type of machine desired and embrace the principles involved in this plan.

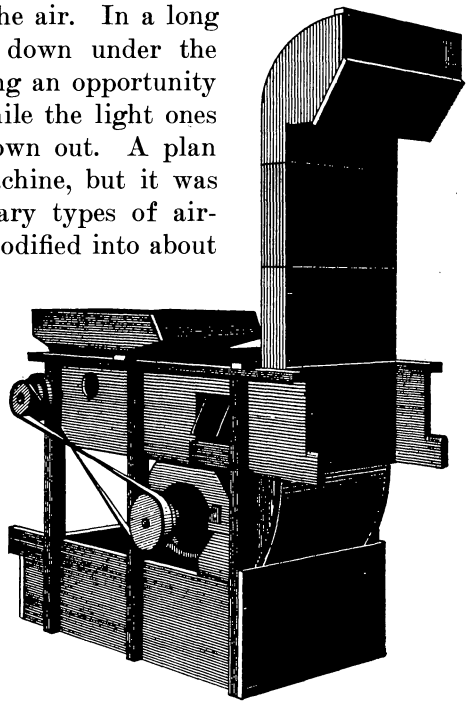

FIG. 3.—Seed separator as modified and used in experiments.

The machine which was modified[a] (fig. 3) was arranged for the seeds to be fed from a hopper (fig. 4, *a*) on to a vibrating screen (fig. 4, *b*, and fig. 5) which would catch the wads of seed and any large bodies of foreign matter and discharge them (fig. 4, *d*) before they reached the flue, but which would allow the individual seeds to pass through its meshes to another vibrating screen with fine meshes (fig. 4, *c*), which delivered them into a short flue (fig. 4, *e*), where they were brought in contact with a current of air driven by a fan from below, which carried the light seeds out through the top of the flue and allowed the heavy ones to drop through into a box below.

[a] A patent on the apparatus described has been applied for on behalf of the Department of Agriculture in order that the public may make and use the device without the payment of royalties.

The principal modifications were to change the gearing so that the fan could be run fast while the frame holding the screen vibrated slowly, and to put additional sections in the flue for the purpose of increasing its length so as to give a longer space in which the separation can take place (fig. 4, *g*, *g*, *g*). The separator flue in the original machine from the point of entrance of seed (fig. 4, *e*) to point of discharge of light seed above was only 6 inches in length. This flue, or tube, was extended to a length of 4½ feet by adding four sections of box-like form which could be set one upon the other and fitted together firmly. This sectional construction of the flues allowed of experimentation with flues of different lengths. The method of construction is illustrated in figure 4, *k*.

The separation depends upon the fact that the effect of the blast exercises itself in a different manner upon the seeds according to their size and specific weight; those seeds having the greatest weight relative to their

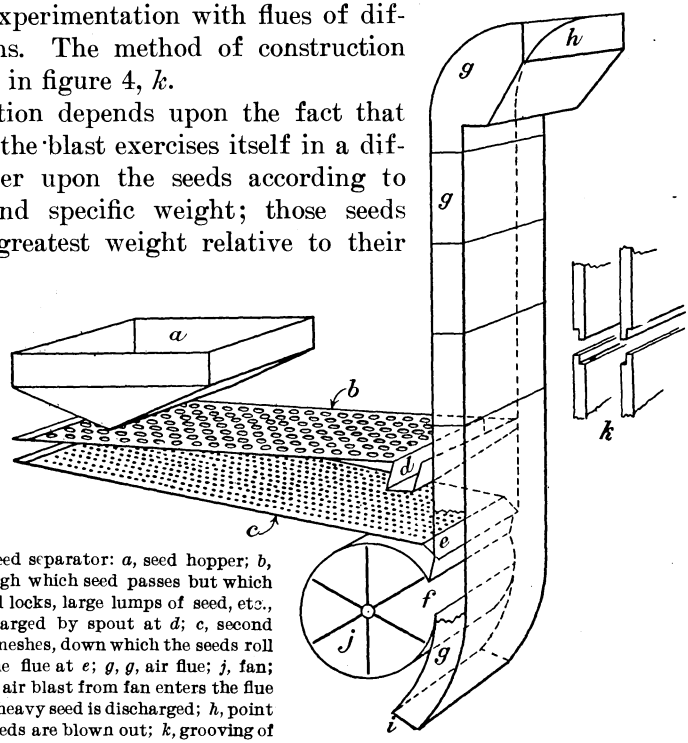

FIG. 4.—Plan of seed separator: *a*, seed hopper; *b*, first sieve, through which seed passes but which removes diseased locks, large lumps of seed, etc., which are discharged by spout at *d*; *c*, second sieve, with fine meshes, down which the seeds roll and fall into the flue at *e*; *g*, *g*, air flue; *j*, fan; *f*, point at which air blast from fan enters the flue *i*, point at which heavy seed is discharged; *h*, point at which light seeds are blown out; *k*, grooving of top and bottom of sections of flue, showing how sections are constructed to fit into each other.

size drop through the blast, while the light ones having a large surface in proportion to their weight are unable to resist the blast and are therefore carried off through the flue. The separation, therefore, is not entirely in accordance with the absolute weight or size of the seeds, but this does not seem to be necessary, as it is more important to get those having the greatest weight in proportion to their volume. It quite frequently happens that large seeds are relatively very light and inferior owing to shrunken or imperfectly developed kernels, yet they may have a rather high absolute weight. They are, however, probably not so desirable as smaller seeds having the

same absolute weight, because their hulls being larger represent a greater percentage of their weight; consequently the kernel, which is the most important part of the seed, necessarily represents a smaller percentage of the gross weight than in the case of small seeds having the same weight.

In order to secure the most satisfactory separation it is necessary to have the machine run at a uniform speed which has been tested and found to give good results. The best separation will thus be obtained where the machine can be attached to some power plant or run by a gasoline or kerosene engine. In many cases power can probably be obtained in the gins. While it is better to procure power from an engine, a very fair separation can be obtained with hand power. To secure a thoroughly satisfactory separation requires some practice and experience with the machine, as the air blast must be properly regulated. If only one separation is to be made the speed must be regulated so that from one-fourth to one-half of the seed is blown out at the top of the flue as light seed. While in general it is only the light seed that is blown out, still some good seed will doubtless in all cases be blown over. As the light seed can be utilized in other ways, this is not a serious fault. If the most perfect results are desired, the heavy seed of the first separation should be run through the separator a second time. A double separation, however, in most cases will probably not be found practicable or necessary if the first separation has been properly done.

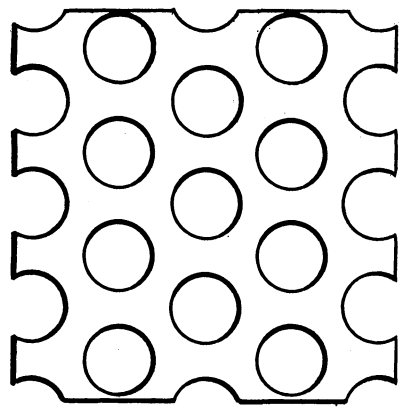

FIG. 5.—Section of first sieve, showing size of meshes.

TESTS OF SEPARATED SEED.

After separation it is very easy to detect a difference in the appearance of the light and heavy grades. In the heavy grade the seeds are plumper, more uniform, and have a much better general appearance. In order to determine the relative weights of the different grades a quantity of seed was separated into four grades, which for convenience were designated as heavy, medium, light, and very light, and 500 seeds were taken from each grade and accurately weighed, giving the following results: The heavy seeds weighed 81½ grams; the

medium, 77½ grams; the light, 74½ grams, and the very light, 62½ grams. After separating another lot of seed into three grades—heavy, medium, and light—a box of seed containing almost a bushel was taken from each grade and weighed, with the following results: The heavy seed weighed 25¼ pounds; the medium, 22⅝ pounds, and the light, 20⅝ pounds. It is thus demonstrated that the separation is in accordance with the weight of the seeds.

To determine the relative percentage of germination of seeds from the different grades and as far as possible to get suggestions as to the relative vigor of the resulting plants, a small test was made in the greenhouse. For this test a quantity of seed was separated into four grades—heavy, medium, light, and very light—and 350 seeds were taken from each grade and planted in practically pure sand. The results are given in the following table:

TABLE 1.—*Germination of 350 seeds of various grades planted in greenhouse on March 2, 1906.*

Grade of seeds.	Number of seeds germinated.							
	Mar. 8.	Mar. 9.	Mar. 10.	Mar. 11.	Mar. 12.	Mar. 13.	Mar. 14.	Mar. 16.
Very light	80	115	174	188	218	224	226	228
Light	52	86	196	253	290	290	292	294
Medium	26	55	169	236	261	270	272	273
Heavy	20	54	175	246	279	292	297	305

For some cause the plants from the medium grade began damping off very soon. It is likely that they were watered too freely. In any case the results from this grade are not considered reliable. It will be observed that a large percentage of all grades germinated, but that the highest percentage of germination was in the case of the heavy seeds. An interesting point in this connection is the fact that the light seeds germinated more quickly than the heavy ones, as can be seen by referring to the table. However, the most striking difference was in the appearance of the resulting plants from the various grades. Many of those from the light grades were yellow and unhealthy in appearance, while those from the heavy grade appeared to be much stronger and more vigorous.

In order to determine what advantage would be gained by eliminating in such separation the light and inferior seeds and planting only the heaviest and best developed ones, careful tests were made in 1906 at Lamar, S. C., in cooperation with Mr. C. L. Reynolds, and at Hartsville, S. C., on the farm of J. L. Croker & Co. For the test at Lamar, a quantity of Hawkins seed was separated, and the heavy seeds and the unseparated seeds of this variety were planted in alternate rows on about 2 acres of land, i. e., approximately 1

acre of each. There were twenty rows of each kind. The resulting yields are given in the following table:

TABLE 2.—*Yield of seed cotton obtained in test at Lamar, S. C.*

Kind of seed planted.	First pick.	Second pick.	Third pick.	Total yield.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Heavy (20 rows)	375	253¼	419	1,047¼
Unseparated (20 rows)	335	228	381¼	944¼

In this test the yield resulting from the heavy seed was 103 pounds, or 10.9 per cent, more than the yield from the unseparated seed.

For the test at Hartsville a quantity of Jones's Improved seed, which was grown on the Coker farm at Hartsville in 1905 and selected for planting in 1906, was separated, and about an acre of land was planted with the heavy seed and the same area with unseparated seed, the two kinds being planted in alternate rows over the entire area. There were fourteen rows of each kind, and the yields are shown in Table 3.

TABLE 3.—*Yield of seed cotton obtained in test at Hartsville, S. C.*

Kind of seed planted.	First pick.	Second pick.	Third pick.	Total yield.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Heavy (14 rows)	158¾	793	212⅞	1,164⅝
Unseparated (14 rows)	139	715¾	221⅛	1,075⅞

As shown by Table 3, in the test at Hartsville the heavy seed yielded 88¾ pounds of seed cotton, or 8.25 per cent, more than the unseparated seed.

Thus it is seen that in both of these tests, which were accurately conducted under actual field conditions, there was a substantial difference in favor of the heavy seed. If the seed cotton is rated at 4 cents a pound, the differences in the yields obtained at Lamar and Hartsville are approximately equivalent to $4.12 and $3.55 per acre, respectively. At first thought this no doubt appears to be a rather small difference, yet it must be remembered that only a very slight outlay is involved in getting this additional yield. It is estimated that the cost of separation need not exceed 10 cents a bushel. In fact, on most farms the regular laborers have sufficient spare time to do this work without any additional expense, so that practically the only expense involved is the cost of picking the extra quantity of cotton which is produced. In the case of both of our tests the separation resulted in a net profit of more than $3 an acre after deducting the necessary amount for all extra expenses. The increase in the yield on the two tests averaged only about 10 per cent, but in view of the fact that this increase does not involve a corresponding

increase in expenses the profits on the crop are increased by a much greater percentage. For instance, if the profit on an acre of land is $10 under ordinary conditions, the net increase by separation is more than 30 per cent of the profit obtained without the separation.

So far as can be judged from the evidence which has thus far been obtained, this method of separation seems to afford a simple, practical, and inexpensive means of materially increasing the yield and greatly increasing the percentage of profit from a cotton crop, and it is quite likely that while it is possible to realize a greater yield it will also bring about a general improvement, or amelioration, of the variety which is grown. Should it be possible to bring about an amelioration in this practical way, it will not, of course, be comparable to scientific selection, which deals with individuals, yet it will probably lead to the progressive improvement of the crop and counteract degeneration.

In the examination of cotton in the field it is almost impossible to recognize differences in yield unless such differences are very extreme. In neither of the tests conducted by the writers at Lamar and Hartsville, S. C., could the superiority in yield of the rows planted with heavy seed be surely distinguished by the eye. It was necessary to pick and weigh the product to determine definitely the results. Planters are therefore cautioned against concluding from an examination in the field alone that separation has been ineffective. The product must actually be weighed to determine the difference in yield.

SEPARATION OF SEA ISLAND COTTON SEED.

The writers have made no tests of heavy and light Sea Island cotton seed, but there would seem to be no reason why the separation in this case should not give increased yields similar to those obtained with Upland cottons. When Sea Island and Egyptian seed are separated on the machine a very perfect separation of light and heavy seed apparently results. In connection with his experiments in 1906, Mr. W. A. Orton, of the Department of Agriculture, planted some Sea Island seed which had been separated with the apparatus previously described and made some notes on the germination of light, heavy, and unseparated seeds which show that in rows of equal length the germination was as follows: Light seed, 188 plants; heavy seed, 327 plants, and unseparated seed, 237 plants. While this experiment was not sufficiently extensive or carried far enough to show conclusively the superiority of the heavy seed, it clearly indicates what may be expected.

The A. P. Brantley Company, of Blackshear, Ga., acting under the advice of Mr. Orton, constructed a machine on the plan of that devised by the writers, and have separated large quantities of Sea Island seed for planting during 1907. The different grades of seed separated by them are shown in figure 6. The pile of seed A is the

unseparated seed as it comes from the gin. Mixed with the seed is a considerable quantity of seed cotton, mainly in diseased locks, which the gins are set to throw out. These diseased or injured locks (fig. 6, B) are separated by the first sieve (see fig. 4, *b*) and are dis-

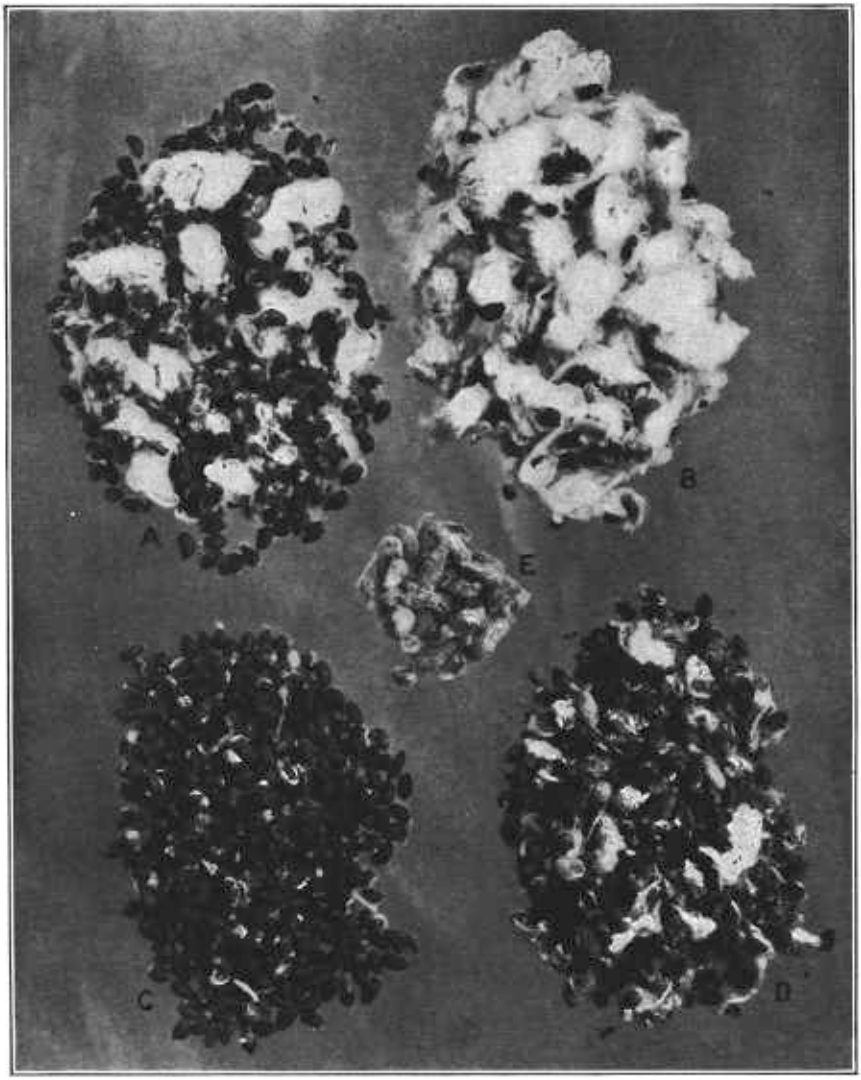

FIG. 6.—Separated Sea Island cotton seeds: A, seeds before separation; B, diseased locks and lumps removed by first (large-meshed) sieve; C, heavy smooth seed, falling down in air flue; D, light, diseased, and hybrid seed, blown out at top of flue; E, a few of the hybrid fuzzy seeds selected from mass of light seed (D).

charged without passing through the flue. This material is afterwards run through a saw gin and converted into linters, the value of which is about 5 cents a pound. The heavy seed, which is used for

planting, is shown in figure 6 as C, and the light seed, with which are mixed many fuzzy seeds, as D. A lot of 85 pounds of seeds after separation by the Brantley Company consisted of 76 pounds of cleaned seed, 7½ pounds of imperfect seed, and 1½ pounds of cotton. It is probable that the cleaned seed in this case should have been run through the separator again under an increased air blast, as the large percentage of cleaned seed, 76 pounds out of 85 pounds, indicates that the separation into light and heavy grades was not sufficiently thorough to obtain the full benefit of the operation.

Sea Island cotton seeds are smooth, lacking the fuzz which covers the seed of Upland cotton, and they therefore do not require to be rolled before separation. An additional advantage of importance gained by the separation of Sea Island seed is that this process will eliminate all fuzzy seeds, as these are easily caught by the air and blown out with the light seed. Great difficulty has been experienced by Sea Island cotton planters, especially in inland regions, in keeping their seed pure, owing to accidental mixture with Upland seed, which is more generally grown, and also owing to impurities introduced by accidental crossing or hybridizing with Upland varieties, which is a very general and common source of degeneration in Sea Island seed. Fortunately, such accidental hybrids with fuzzy-seeded Upland varieties practically always produce fuzzy seeds, and these hybrid seeds and seeds of any Upland cotton accidentally mixed with the Sea Island cotton are eliminated by the separation (fig. 6, D and E). In Sea Island cotton, where the success of the industry depends upon keeping up the high quality and extreme length of the fiber, it can readily be seen that the separation of the seed is of great value because of this one feature, if no other advantage is gained.

HOW TO OBTAIN THE NECESSARY APPARATUS FOR COTTON SEED SEPARATION.

The only two pieces of apparatus necessary to separate cotton seed, as described in this bulletin, are the seed roller and the seed separator. The seed roller can easily be made by any farmer from a petroleum barrel, as previously described. A seed separator of the kind described is not as yet manufactured and at the present time can not be purchased. It is, however, very easy to make an apparatus of this kind. Air-blast fanning mills, similar to that shown in figure 3, can be purchased, and a carpenter can easily make an extension of the flue, as described. Aside from the extension of the flue, the only change necessary is to modify the gearing so that the fan may be run at a rapid rate without increasing the speed of the sieve shaker. By studying the description of the separator previously given, any carpenter should be able to make these changes at slight expense to the planter.

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